INCUBATION and BROODING of CHICKENS

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THE REPRODUCTION of the flock from year to year is one of the poultry raiser's most important problems.

To insure best success in incubation and brooding, the hatching eggs must have come from breeding stock of the highest possible quality and free from disease.

The use of the incubator and the brooder is recommended as the most economical and labor-saving way of reproducing the flock.

The best conditions of incubation are provided by proper temperature and ventilation and an adequate supply of moisture.

The most favorable conditions of brooding are provided by proper temperature according to the age of the chicks and climatic conditions, plenty of room, not more than about 400 chicks in one flock, good ventilation, and clean houses and soil.

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INCUBATION AND BROODING OF CHICKENS

By M. A. JULL,[1] *poultry husbandman*, and A. R. LEE, *associate poultry husbandman, Bureau of Animal Industry, Agricultural Research Administration*

Contents

REPLACING THE FLOCK

THE IMPORTANCE of adopting the most efficient methods of incubation and brooding can be appreciated when it is realized that between 275,000,000 and 300,000,000 laying pullets are raised in the United States every year to replace that number of hens. The number of laying hens kept on the farms of the United States annually ranges between 450,000,000 and 500,000,000, of which more than 60 percent are culled or die by the end of the laying year. Hens produce the most eggs during their first laying year, production falling off about 20 percent the second year, and decreasing gradually each succeeding year. It is important, therefore, to cull the laying flocks closely at least once annually to replace the poor producers with more profitable producing pullets, maintaining a laying flock of over 60 percent pullets. Many poultrymen dispose of all birds by the end of their first laying year, keeping only pullets for egg production.

The necessity of renewing more than 60 percent of the flock each year is one of the most important problems in poultry raising. This replacement process is one of the principal causes of failure on the part of many beginners. Furthermore, methods of incubation and brooding affect to a considerable extent the profits to be made out of the laying pullets raised. A poor hatch represents an economic loss for which no compensation can be made. A high mortality among chicks represents an economic loss also; the higher the mortality the more certain that the breeding stock was of inferior quality or was diseased or that methods of brooding were inefficient.

INCUBATION

The object of incubation is to obtain the largest possible number of good chicks in proportion to the number of eggs set. Artificial

[1] Resigned in August 1936. The revision of this bulletin was made by the junior author.

methods of hatching chicks are very generally used and it is estimated that more than 85 percent of all chicks produced now come from commercial hatcheries. On farms where 200 or more chicks are raised annually artificial methods of hatching and brooding have entirely replaced natural methods. Smaller farm flocks of chickens are also raised artificially although natural methods are used on many farms. Where Leghorns or other nonsitting breeds are kept, artificial methods of incubation and brooding must be used.

Artificial incubation permits the hatching of chicks early in the spring so that the pullets will mature and begin laying in the early fall, when eggs are in demand. Hatching under hens, on the other hand, is usually too late to produce early pullets. Where the chickens are hatched and raised artificially there are smaller losses in the flock from lice and other parasites. Another outstanding advantage of the incubator is that the chicks can be hatched in larger units and at any desired time. The use of incubators or the purchase of day-old chicks makes it possible to raise the chickens in good-sized flocks under brooder stoves, which greatly simplifies and reduces the labor of producing and rearing the birds.

TIME TO HATCH

It is very important that chicks be hatched early, because the profits in poultry raising depend, to a considerable extent, on fall and early winter egg production. The larger part of poultry receipts is obtained from eggs. This is true both in farm poultry raising and in commercial poultry plants. Farmers and commercial poultrymen should realize, therefore, that one of the most important things to consider is getting good egg production the year round.

It should be borne in mind that the price of eggs is highest from about the first of September to the middle of December, and if egg production is good during that period, profits in egg production are increased greatly. Unfortunately, however, on most farms and in many commercial poultry plants, it is during the fall and early winter months that the old hens are in the process of molting and pullets have not yet commenced to lay. Thousands of farmers could obtain greater returns from their flocks if their pullets were hatched early enough to begin laying in time for the high prices during the fall and early winter months. Farmers often fail to realize that pullets are almost the only source of eggs at that time of the year because hens are molting and may take from 30 to 90 days to go through the complete molt.

Poultry producers can control production to a considerable extent by hatching pullets at the proper time of the year so that they will be in good laying condition by September or October. There are several distinct advantages in hatching pullets early. In the first place the earlier they are hatched the earlier they commence to lay. Moreover, it has been demonstrated that early maturing birds usually make the best annual layers. The pullets should be well-grown and of good size before they start to lay; otherwise the first eggs laid are apt to be excessively small and the birds will not be well prepared for heavy egg production.

Pullets of any of the lighter breeds, such as Leghorns and Anconas, should come into laying when about 5 to 6 months old, and those of

the heavier breeds, such as Plymouth Rocks, Rhode Island Reds, New Hampshires, and Wyandottes, should begin laying when from 5½ to 6½ months old. Therefore, in order to take advantage of the high egg prices during the fall and winter months, pullets should be hatched about 6 months prior to October, in the case of Leghorns, and about 7 months prior to the middle of October, in the case of the heavier breeds. In the Southern States, where the growing season is much longer than in the North, it has been found that chicks hatched after the middle of April frequently do not do well. In the South, therefore, most of the Leghorn chicks should be hatched before the first of April and most of the heavier breeds by the middle of April, while in the North, most of the Leghorn pullets should be hatched before the middle of May, and the heavier breeds by the middle of April. In 1941 more than 80 percent of chicks in commercial hatcheries were produced between February 1 and June 30, 23 percent being produced in April, followed in order by May, March, June, and February.

Farmers should hatch their chicks early if the highest profits are to be made in egg production the following year. It has been demonstrated repeatedly that late-hatched chicks do not do as well as early-hatched ones. In the case of the early-hatched chicks the males may be sold as broilers early in the season, when prices are usually slightly higher than later in the season. Still other advantages of hatching chicks early are that early fryers are for sale before the great bulk of the poultry goes to market in the fall, and that one may have well-matured roasters ready for the Thanksgiving market.

One of the greatest troubles with the marketing of poultry in the United States is the excessive number of immature, scrawny chickens sent to market. Early hatching will do a great deal to counteract this condition because the cockerels will have a longer season in which to build a proper frame and then will have some time to put on a finish. In view of these many advantages, farmers and commercial poultrymen should do everything possible to avoid late hatching, which is rarely as profitable as early hatching.

SANITATION IN INCUBATION

The necessity for proper sanitation in incubation cannot be overemphasized, because lack of sanitation may be the cause of poor hatches and high mortality in the chicks. The hatching eggs should come from healthy breeding stock kept in strictly sanitary quarters. The eggs should be clean, because dirt on the shells may harbor disease organisms. Sitting hens should be treated with sodium fluoride to rid them of lice, and the nests should be kept clean and free from lice and mites. The trays should be scraped and the incubators thoroughly cleaned and disinfected to destroy disease organisms before eggs are placed in them. Be sure that all down and dirt have been removed from the incubator, and disinfect the interior of the machine as well as the egg trays and nursery drawers after each hatch with cresylic disinfectant in a 3-percent solution. The larger, forced-draft incubators are usually disinfected by fumigation with formalin.

When using formalin, avoid breathing the fumes. Care should be taken in using disinfectants as they are poisonous to man and livestock.

SELECTING HATCHING EGGS

The careful selection of eggs for hatching is a very important matter because the kind of eggs incubated determines, to a large extent, the quality of chicks hatched. Selecting eggs from high-quality breeding stock is the most important consideration. Fertile eggs of good hatching quality are necessary for good hatches. It is advisable to mate the breeding stock about 2 weeks before eggs for hatching are to be saved. Usually fairly good fertility may be obtained from the light breeds of poultry 5 to 6 days after they are mated and after 7 to 10 days in the general-purpose breeds. In cold weather the eggs should be gathered two or three times a day to prevent them from becoming excessively chilled. All eggs for hatching should be uniform in shape and size, and sound in shell.

The size of the eggs used for hatching is very important because there is a high correlation between the size of eggs used and the size of chicks hatched. Furthermore, the continued use of small eggs for hatching purposes would soon result in a decrease in the size of eggs shipped to market. The most careful attention therefore should be given to the selection of the eggs for hatching on the basis of size, and it is desirable to use for incubation, no eggs weighing less than $1\frac{11}{12}$ ounces.

In the case of varieties of chickens that lay white-shelled eggs, all eggs used for incubation should be free from tints. This is an economic factor which has caused trouble in some strains of White Leghorns. In marketing eggs there is a tendency for the trade to discriminate against white eggs with tinted ones mixed in with them.

All eggs should be tested for cracked shells. This can be done readily by tapping two eggs together. If there is a resonant sound, both eggs are sound in shell; but if there is a dull sound, one of the eggs is cracked and should not be used for incubation.

Eggs for incubating should not be washed. Therefore, dirty eggs should ordinarily be rejected. If it is necessary to use such eggs, the dirt may be scraped off with steel wool or with a knife. The more careful the selection of hatching eggs, the better the results.

Only fresh eggs should be set. Eggs deteriorate rather quickly after they are about 7 days old, while eggs 4 or more weeks old usually do not hatch at all. If the incubator capacity is relatively large, and a large number of eggs have to be saved before setting time, they should be kept in a room free from drafts and dust and with a temperature of about 50° to 55° F. It is not necessary to turn the eggs unless they are held more than 7 days, after which they should be turned daily, and it is rarely advisable to save eggs for hatching longer than 2 weeks. The simplest way to hold hatching eggs is to keep them in baskets or egg cases (fig. 1), with the large end of the egg up, or they may be kept in a horizontal position in cabinet trays and turned by hand.

HATCHING WITH HENS

When raising chicks with hens it is necessary to have good brooding hens and properly constructed nests, and to give the hen careful attention during the incubation period. The number of eggs in a setting ranges from 11 to 17, the smaller number in the early part of the season, when the weather is cold, 15 later in the spring, and 17

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FIGURE 1.—Room and equipment for holding hatching and market eggs at a temperature of about 55° F. The large cabinets at left and wire baskets allow for ventilation. Buckets and egg cases also may be used for holding eggs.

when the weather is warm. Breeds of the general-purpose type, such as Plymouth Rocks, New Hampshires, Wyandottes, and Rhode Island Reds, are among the best sitters.

The nest should be built carefully with fine, soft hay, straw, or leaves. It should be about 16 inches square and 6 inches deep. If the nest is too deep the eggs may pile up and break. The room for the sitting hens should be secluded and it should be apart from the houses for layers and breeders.

The best time to set a hen is after dark. Have the nest carefully prepared and, if convenient, place 2 or 3 infertile or artificial eggs in the nest and do not disturb her the first day. When she is sitting well the eggs may be placed under her. At the time of sitting it is very necessary to dust the hen thoroughly with sodium fluoride. Hens should not be dusted just before the chickens hatch. Some hens may become so badly infested with lice that they will leave their nests. To treat the hen, take her by the feet, holding her head downward, and rub pinches of sodium fluoride well into her feathers, especially around the vent.

The nest should be examined frequently to be sure that no eggs have been broken or, in case any have been broken, the shells and soiled nesting material should be removed and the rest of the eggs should be washed with warm water to remove any material that came from the broken eggs.

Sitting hens are usually fed once a day, the feed consisting of whole or cracked grains. Grit and clean water should be available at feeding time. Do not disturb the hen at hatching time, but let her sit quietly after the nineteenth day. See that she does not leave the nest with the first chick she hatches; she should be kept on the nest until after all the chicks are hatched.

HATCHING WITH INCUBATORS

Artificial incubation is used to some extent all over the country by all kinds of poultry raisers. Practically all of the chicks for reproducing back-yard flocks and a large majority of those for commercial poultry flocks and general farm flocks come from commercial hatcheries. It is estimated that these hatcheries produce more than 85 percent of all chicks raised in this country.

Types of incubators

There are on the market many makes of incubators that are being used successfully in various parts of the United States. These incubators may be divided into two general groups, namely, the small, single-tier machines holding from 50 to 450 eggs, usually heated with kerosene lamps or with electricity, and the mammoth incubators. Most of the mammoth incubators are either of the cabinet- or the room-type design in which the heat is circulated by forced draft. Electricity, oil, gas, or coal are used for heating these machines, electricity having largely replaced other methods of heating in most parts of the country. These forced-draft incubators are made in many sizes, varying from less than 1,000 to over 75,000 eggs in one machine. Many of the mammoth machines have separate hatchers to which the eggs are transferred from the incubator on the seventeenth or eighteenth day of incubation.

The small incubators are of two general types, hot-air and hot-water, the former being most commonly used. Electricity is used as the source of heat for many of the small incubators; it is easier to regulate and has less fire risk than oil heat.

The correct temperature, the location of the thermometer, and many other incubation factors are affected by the type of incubator. Very specific directions are supplied by the manufacturers of the mammoth incubators. No attempt will be made in this bulletin to include detailed information on the operation of all types of incubators, but only on the operation of the small, single-tier machines.

Two styles of incubator thermometers are used in the small single-tier machines. One is placed on the egg tray, whereas the other is hung over the eggs so that the bulb just clears them. Because of the differences in temperature at various levels in these machines, it is very important that the thermometer be located at the proper level. Accurate thermometers are essential for good results in incubation. Thermometers may be tested by comparing them with a clinical thermometer in water heated to about 100° F.

Selecting an incubator

Cheap incubators are usually less reliable, require more attention, and wear out much sooner than higher priced ones. As the value of

the machine is small compared with the value of the eggs used during the normal life of an incubator, it is poor economy to purchase an unreliable machine.

The best sized incubator to buy depends on circumstances. It takes about as much time to care for a 60-egg machine as for one with a capacity of 360 eggs; it is generally advisable to get one of at least 150-egg capacity. Many poultry raisers like to have an incubator capacity large enough to hatch the bulk of their stock in 2 to 4 hatches, so that much time will be saved in looking after the incubators and brooders, and so that the chickens will be more even in size than those hatched when the incubating period extends over a longer time. It may pay to have even a larger egg capacity and do some hatching of eggs from other flocks.

The hatching capacity required for the reproduction of the flock from year to year depends on the size of the flock to be reproduced as well as on the number of chickens required to be hatched at one time. In the case of the 200-bird flock, 50 of which are yearlings, for breeding purposes and the remaining 150 are pullets, at least 175 pullets should be raised to maturity to allow the culling out of 25 of the poorer pullets. To have 175 pullets in the fall would mean that a flock of 350 chicks would have to be raised, because practically half the flock would be male birds. If allowance is made for about 15 percent mortality during the spring season, 350 chicks in the fall of the year would mean that approximately 420 chicks would have to be hatched. If the chicks are hatched in 2 successive hatches, 420 chicks would require 210 chicks for each hatch, or about 350 eggs would have to be set each time, which would allow for a 60-percent hatch, giving 210 chicks. For 2 hatches, therefore, about 700 eggs would have to be set.

The Incubator Room

Incubators are successfully operated in a great variety of places. If only a few small machines are used on a farm they are generally kept in the cellar or in a room of the house. A well-ventilated cellar is usually much better than a room, because the temperature is subject to less variation, the air usually contains more humidity, and there is less fire risk. It is desirable to make the ceiling and wall fire resistant around the incubators. A special cellar or incubator building should be provided when mammoth machines are used. The main essentials are a room which is not subject to great variations in temperature, which is well ventilated and is not too dry. Most commercial hatcheries are located in well-insulated buildings where the incubators are above the ground level. These large cabinet incubators are usually equipped with automatic devices by which humidity in the machines may be maintained at the desired point.

The incubator room should be large enough to allow the attendant to work around the machines conveniently. From 8½ to 9½ feet is considered a desirable height for the incubation room and about 70° F. the most desirable room temperature. The shape and size of the room should be governed by the size of the incubators to be installed. Manufacturers of the various mammoth incubators furnish room plans for use with their respective machines. Many incubator rooms

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are provided with some system of ventilation in addition to the windows, in others the ventilation is controlled entirely by the windows. The essential purpose is to keep the air in the room fresh and sweet.

Installing the Incubator

Small incubators should be installed according to the manufacturer's directions. A spirit level is used to see that the machines are perfectly level. Be sure that all parts of the incubator are in their proper positions and that the regulator works freely. If the door of the incubator sticks, do not plane off the edge until the machine has been heated and thoroughly dried.

Most operators attend to their incubators at least three times daily and occasionally make extra trips, as conditions require. Incubators require careful and regular attention, since neglect generally affects the hatch.

Regulating the Temperature

Manufacturer's directions for the operation of their incubators should be followed closely until experience enables the operator to determine any minor variations that may be desirable. The following additional suggestions may be useful to those operating incubators which are not forced-draft machines. Run the machine at about 102½° F. for at least 2 days before putting the eggs in. It takes several hours for the machine to come back to its correct temperature after the eggs are put in; therefore the regulator should not be touched during that time. See to the regulation of the temperature of the incubator before opening the door of the machine to attend to the eggs. The machine should receive care enough to keep the temperature nearly even.

The correct temperature depends on the type of machine and on the position of the thermometer in the egg chamber. A hanging thermometer in a single-tier machine is operated at a temperature of about 102½° F. the first week and 103° the last two weeks. In a good batch the chicks in the eggs begin to pip on the evening of the nineteenth day. All of the chicks should be out of the shell by the morning of the twenty-first day. If the hatch is much earlier or much later it indicates that temperature during incubation has not been correct.

The forced-draft type of incubator has uniform heat throughout the machine and is operated at a lower temperature than the single-tier incubator. The large machines that are not equipped with hatching trays are operated at about 99¾° to 100° F., and separate hatchers for these machines are run at about 97°. Incubators which do not have separate hatchers are usually operated at about 99° to 99½°.

Care of small incubators

Machines heated by oil should have the lamps cleaned and filled once daily. The wick should be trimmed by scraping the charred portion off with a knife or by cutting the wick with scissors. The burners should be kept free from dirt and thoroughly cleaned after each hatch. A new wick for each hatch is a good investment, thus eliminating any danger of the wick becoming too short. Turn the eggs before caring for the lamp, so that there will be no chance of getting oil on the eggs.

Lamps should never be filled while burning. The flame is apt to increase; therefore, it is advisable to check the lamps after they are lighted. Small electric incubators are easier to regulate, require less labor and are less likely to catch fire than lamp-heated machines.

Turning and cooling the eggs

Eggs are usually turned twice daily in the lamp machines from the second until the seventeenth or eighteenth day, after which the chicks are due to pip. In large incubators various mechanical devices are used for turning the eggs, but most poultrymen using small machines prefer to shuffle the eggs with their hands, removing a few from the center of the tray and working the others toward that point, placing on the sides of the tray those taken out. When time-saving mechanical devices are used, it is usually advisable to turn the eggs three to five times a day. In lamp machines, after turning the eggs, reverse the egg trays end for end and from one side of the machine to the other in two-tray incubators.

Eggs do not need to be cooled during incubation unless they have been subjected to a high temperature. Eggs are sometimes incubated at a subnormal temperature for several hours, because of interruption of electric current or other failure of the source of heat. Such eggs will hatch after being exposed to a temperature as low as 50° F. for several hours during the second week of incubation, but they will not stand such exposure during the earlier or later stages.

Moisture supply

Moisture is usually added to incubators in most parts of the country. The amount needed depends on the climatic conditions and on the room where the incubator is used. Too much moisture in the egg chamber may prevent the normal evaporation necessary to allow space enough for the chick to turn in the egg and break the shell, while too little moisture may cause the chick to become dried and stick to the shell. As the weather becomes warmer, more moisture is generally used than earlier in the season.

Moisture is automatically controlled in the forced-draft incubators by the use of a humidifying device which keeps the moisture at the desired point regardless of the conditions outside the incubator. A relative humidity of about 60 percent should be maintained in the incubator. The desired humidity is obtained when the wet-bulb reading is about 86 in the incubator and about 88 in the separate hatcher. In the small-lamp and other single-tier incubators moisture may be supplied by placing a pan of water in the incubator below the egg tray or by sprinkling the eggs with warm water.

Figure 2 shows the comparative size of the air cell in an egg on the seventh, fourteenth, and eighteenth days of incubation in a forced-draft incubator. The air cell would be slightly larger in an incubator in which the moisture is not controlled automatically. The size of this air cell varies with the size and shape of the egg, and the shape also varies in different eggs. If the air cell is too slow in enlarging, too much moisture has been supplied, whereas too large an air cell indicates that more moisture should be given.

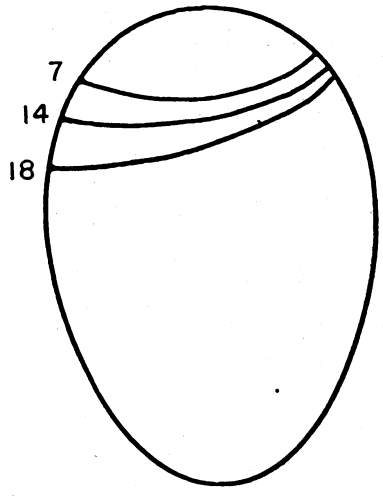

FIGURE 2.—Diagram showing the air cell on the seventh, fourteenth, and eighteenth days of incubation in forced-draft incubators.

Testing the Eggs

Eggs may be tested once or twice during the period of incubation. When two testings are made, the infertile eggs and those with dead germs are removed about the seventh day; the eggs in which the embryos die after the first test are taken out on either the fourteenth or the eighteenth day. White eggs can be tested on the fourth or fifth day, but the development in brown-shelled eggs cannot be easily seen by the use of an ordinary egg tester until about the seventh day.

With special testing apparatus it is possible to detect fertility in eggs after 15 to 18 hours of incubation.

Some operators of mammoth incubators make one test, when the eggs are moved to the separate hatchers on the seventeenth or eighteenth day. This is a tray test made by moving a bright spot light under the tray of eggs, taking out any eggs which are clear or show little development. Many incubator operators do not do any testing.

Various types of commercial egg candlers or testers equipped with electric lights are used for testing during incubation of the eggs (fig. 3). Some manufacturers of lamp incubators furnish inexpensive testing chimneys which fit the incubator lamps. The testing is usually done in a fairly dark room.

The eggs are tested with the large end up, so that the size of the air cell as well as the condition of the embryo may be seen. The infertile egg, when held before the candling device, looks clear, except for the yolk shadow. A fertile egg shows a small, dark spot, known as the embryo, with a mass of little blood vessels extending in all directions, if the embryo is living. A live germ is spiderlike in appearance and moves freely when the egg is rotated in candling. If the embryo is dead and the egg has been incubated for at least 48 hours, the blood settles away from the embryo toward the edges of the yolk, forming in

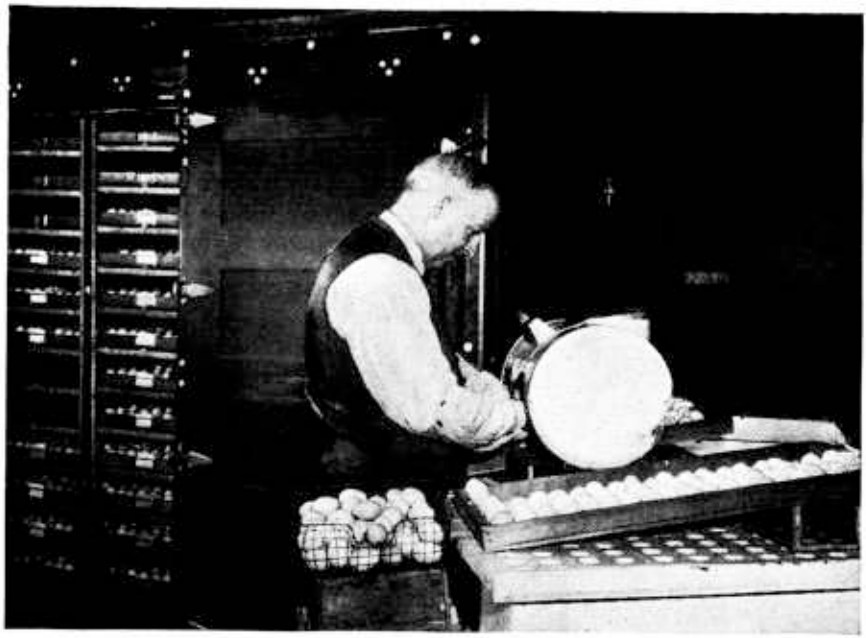

FIGURE 3.—Testing eggs for fertility and dead germs in an electric egg tester. Note forced-draft incubator in left background.

some cases an irregular circle of blood, or "blood ring." Eggs vary in this respect, some showing only a streak of blood.

On the fourteenth day the eggs containing strong, living embryos are dark and well-filled and show a clear, sharp, distinct line of demarcation between the air cell and the growing embryo, whereas eggs with dead germs are recognized by the absence of blood vessels and by an only partially developed embryo.

Removing the Hatch

Do not open the doors in the small single-tier incubators after the eighteenth day until the hatching is well over unless the machine is overcrowded, as this allows the moisture to escape and lowers the percentage of hatching. These machines are usually arranged with a movable piece of screen in the front of the egg tray, and this is opened when the hatch is completed, so that the chicks can get down into the nursery tray after they are dried off. In the forced-draft incubators, in which the humidity and the temperature are automatically controlled, it will not affect the hatch to open the doors after the eighteenth day provided they are closed promptly.

In the small single-tier machines, remove the shells and eggs with dead embryos and place all the chicks in the nursery trays as soon as the chicks are through hatching, then set the incubator door slightly ajar to allow ventilation so that the chicks will dry off and harden before being removed to the brooder. Chicks that pip but are unable to get out of the shell by their own efforts rarely amount to much if

helped out. If it seems desirable, however, when most of the eggs are hatched and the chicks have dried off so that they will not be injured by opening the incubator door, any which have pipped may be helped out by cracking the shell and placing them back on the egg tray. Keep the temperature in the incubator, taken at a level of the chicks' heads, at about 95° F. for about 24 hours after the hatch is complete, or until the chicks are dry; then remove the chicks to a brooder in a chick shipping box, being careful not to permit them to become chilled while being transferred.

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FIGURE 4.—Chicks in a nursery tray in a forced-draft incubator.

The operation of forced-draft incubators depends on the make of the machine. Most of these incubators have separate hatchers which have only nursery trays (fig. 4). Some forced-draft incubators have a hatchery unit in the bottom or in the top of the machine; others are equipped both with incubator trays and with hatchery trays, all of which are interchangeable. The chicks hatch in the nursery trays and are not disturbed until they are taken to the brooder or placed in the chick boxes for shipment.

Factors Influencing Hatches

Many factors may affect the hatchability of eggs. Some of the causes of a poor hatch are the breeding and feeding of the breeding stock, faulty care of the eggs before incubation, too-low or too-high temperatures, or too-low humidity during incubation. There are

two critical periods during incubation, a low mortality peak occurring on the second to fourth days and a very much higher peak about the nineteenth day.

Optimum conditions of incubation for forced-draft machines are: (1) a temperature of 99¾° to 100° F.; (2) a relative humidity of approximately 60 percent; (3) carbon dioxide content of not over 0.5 percent of the air in the incubator with the oxygen content approximately 21 percent. The eggs should be turned several times a day.

INCREASING DEMAND FOR DAY-OLD CHICKS

More and more farmers are buying day-old chicks instead of incubating eggs. The demand for chicks has resulted in a rapid growth in the hatchery industry, and it is estimated that more than 85 percent of all the chickens raised in farm flocks come from commercial hatcheries. Most young chickens are sold as day-old chicks just as soon as they are taken from the incubators. A small percent of chicks are sold as "started" chickens when they are a few weeks old. In many hatcheries some of the chicks are separated at hatching time according to sex, the pullet chicks being raised for egg production and the cockerel chicks for meat production. These are referred to as "sexed" chicks, in which the Leghorn pullet chicks bring about twice the price of straight-run chicks. This difference in price is not so much in sexed chicks of the heavier breeds, as there is a good demand for the cockerel chicks for broiler production.

Day-old chicks of the highest quality are produced in those hatcheries where the breeding flocks supplying the eggs for the hatchery are inspected carefully and culled rigidly and only the best birds in the flock used as breeders. The poultry plants where the breeding flocks are maintained should be kept in sanitary condition at all times. The eggs sent to the hatcheries should be of good size, as well as uniform in shape and shell color, and of good shell texture.

It is very important that farmers who buy chicks from commercial hatcheries pay particular attention to the breeding and pullorum-disease-control program back of the chicks. A large number of breeders and hatcheries throughout the country are participating in the National Poultry Improvement Plan, which has as its primary purpose the improvement of chicks with respect to production and freedom from pullorum disease. This malady, if uncontrolled, causes high mortality, as it is transmitted through the egg to the chick. The plan is administered cooperatively by an official State agency in each of the cooperating States and the Bureau of Animal Industry of the United States Department of Agriculture. Following proper certification of the quality of his flocks and hatchery products by the State agency, participating flock owners, hatcherymen, or poultry breeders may then use the emblem, designs, and terminology of the National Poultry Improvement Plan.

The four progressive breeding stages of the plan are U. S. Approved, U. S. Certified, U. S. Record of Performance, and U. S. Register of Merit. The four pullorum classes are U. S. Pullorum-Tested, U. S. Pullorum-Controlled, U. S. Pullorum-Passed, and U. S. Pullorum-Clean.

A list of breeders and hatcheries participating in the plan may be obtained from any county agent or extension poultryman. To obtain

a list of cooperators in all States, address a request to the National Poultry Improvement Plan Office, Bureau of Animal Industry, Washington 25, D. C.

BROODING

Given healthy and vigorous chicks as they come from the incubator, it is essential that the conditions of brooding should be such as to promote the most economical growth. The most important factors in artificial brooding, are proper temperature, plenty of room, a constant flow of fresh air, and sanitation. All chickens on commercial farms and most farm flocks are raised by artificial methods. The use of brooders for farm flocks provides for brooding chicks in good-sized flocks, thereby reducing labor, and permits raising chicks early in the season.

SANITATION IN BROODING

One of the most frequent causes of failure in brooding chicks is lack of proper sanitation. Brood coops, brooders, and brooder houses are frequently allowed to get very dirty, and sometimes are never disinfected, with the result that the chicks become infected with coccidiosis and other diseases. Thorough disinfection of brooding equipment and premises will do much to prevent the transmission of the disease from infected to noninfected chicks. All equipment used in brooding chicks, brood coops, and brooder houses should be cleaned and disinfected with cresylic disinfectant before the brooding season begins and after each lot of chicks is brooded. Another very effective disinfectant may be made by dissolving 1 pound of commercial lye and 2½ pounds of water-slaked lime in 5½ gallons of water.

The soiled litter may be cleaned out and renewed after the first 10 days and every 5 to 7 days thereafter. Frequent cleaning of the brooder helps to keep the chicks healthy. However, commercial broiler raisers are getting good results using a deep litter in the brooder house, which is cleaned out only when the chickens are marketed. This litter is raked over frequently and fresh litter added to the surface to keep it dry and clean. Clean litter is very important because the floor soon becomes contaminated and disease is apt to spread from one chick to another.

A common cause of poor growth and high mortality in chicks is contaminated soil. Too frequently chicks are allowed to run with the adult birds on soil which is rarely cultivated or treated for parasites and disease organisms. Care should be taken in farm flocks to keep the young chickens away from the laying flock. To remain free from intestinal worms and various diseases, the chicks should be brooded on land over which the old stock has not been allowed to range for at least 1 year.

If the only yards available have been infected with disease germs, it may be advisable to keep the young chickens on small outside wire floors or sunporches off the ground until 8 to 10 weeks old. A good grass range is most desirable, and chicks should not be raised on bare land. Do not overcrowd the chicks, and do not brood them on sites that were used the year before. The bare land immediately in front of the brooder house should be treated with lime, cultivated, and sowed

to grass or some green crop. The importance of keeping the soil in the brooder field sweet and clean cannot be overemphasized.

Crowding chicks in the brooder may also result in losses, as under such conditions it is difficult to keep the brooder pens sanitary and many chicks may become weak or runty.

BROODING CHICKS WITH HENS

Hens should be fed as soon as possible after the chicks are hatched, as feeding tends to keep them quiet; otherwise many hens will leave the nest. When several hens have been set to come off at the same time, it may be advisable to give the chicks hatching first to one hen and distribute the unhatched eggs among the other hens. In most cases it is best that the hens remain on the nest and brood the chickens for at least 24 hours after the hatching is over.

A hen will brood from 10 to 15 chickens successfully early in the season, and from 15 to 20 in warm weather, depending on her size. In giving chickens to a hen which already has some to brood, it is best to do it at night and to add chicks of the same color and age as those already with her.

Chickens hatched during the winter, when the weather is cold, should be brooded in a poultry house or shed; after the weather becomes more favorable they may be reared in brood coops out of doors. Brood coops should be so made that they can be closed at night to keep out cats, rats, and other animals, but there should be ventilation enough to give the hen and chicks plenty of fresh air. The construction of brood coops should be such as to permit them to be easily cleaned and sprayed. An inexpensive coop is illustrated in figure 5. The floor dimensions of the brood coop should be about 20 by 30 inches and the height from 18 to 26 inches. Plans of brood coops may be obtained by writing to the poultry department of any State agricultural college.

The hen is usually confined in the coop or in a small yard attached to the coop until the chicks are weaned, the chicks being allowed free range after they are a few days old. The use of a small, covered yard attached to the coop gives the hen more freedom and keeps her in better condition than if she is confined to a coop all the time. Brood coops should be moved weekly to fresh ground, preferably where there is plenty of short grass.

ARTIFICIAL BROODING

Brooders with movable stoves or hovers are the most common. Other kinds are the battery brooders and the long continuous brooder house that may be heated by a hot-water-pipe system.

The individual stoves or hovers may use coal, oil, electricity, gas, or wood (figs. 6 and 7). They include all sizes from the 50-chick lamp brooder to stoves with an estimated capacity of several hundred chicks. The coal stove is probably the most popular in sections of the country where coal is generally used and it is especially adapted for cold-weather brooding. Chestnut-size hard coal is generally used in the coal-burning stoves. Stoves adapted for burning soft coal are also available. Some of the other sources of heat are more readily adjusted for mild weather conditions, and all kinds are being used successfully. Oil-heated brooders are very generally used on the Pacific coast and are popular in other regions.

FIGURE 5.—Brood coop for hen with chicks. This coop, which has slats at the front, provides ample ventilation but does not protect the chicks from rats or other predatory animals.

Electric brooders are used where the electric current is dependable and the cost moderate. This type of brooder requires the least attention, is the easiest to maintain at the desired temperature, and offers less fire risk than most kinds of brooders. Lower electric rates and improved types of well-insulated electric brooders have materially reduced the cost of brooding chicks by electricity. Many operators use a piece of insulation board on the floor under the electric brooder or hover. Electric brooders are especially adapted for use in areas that have moderate temperatures.

Battery brooders, which are built from three to six decks high, are designed to keep a large number of chicks in a small space for a few weeks. They are usually made of angle iron, galvanized steel, and heavy welded wire (fig. 8). Home-made batteries may be made with wooden frames, using heavy wire on the floors and front and lighter wire on the other sides. Most battery brooders are equipped with automatic heating devices in each unit but are usually operated in rooms in which supplemental heat is provided. Electric heating units, being easily controlled, are especially adapted for battery use but hot-water, oil-burning, and other types of batteries are all used with good results.

Continuous brooder houses, heated either with a central hot-water-pipe system or with individual brooder stoves, are used on a few large poultry farms and for commercial broiler production. Various types of individual brooder stoves, such as coal, oil, wood, and electric are

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FIGURE 6.—Electric brooder suitable for a small number of chicks. Note shipping box in the foreground, from which the chicks have just been removed.

24386-B

FIGURE 7.—A coal-stove brooder with a brood of chicks. This type of brooder is well adapted for brooding chicks in flocks of from 150 to 400. Note particularly the wire fence, which prevents the chicks from going too far from the heat.

used in these brooder houses without any supplemental heat. Supplemental heat is provided in some cases, especially where electric brooders are used. These long brooder houses are excellent for broiler production and may be used successfully with sun porches for brooding other kinds of chicks, but do not provide good outside yard or range conditions for raising pullets. A hot-water-pipe brooder house can be used to advantage only for brooding chicks and involves a heavy investment where chicks are brooded only during a few months of the year.

10755–A

FIGURE 8.—Battery brooders with electric-heating units in each compartment.

Selecting a Brooder

The selection of the brooder is a very important matter because the successful brooding of chicks is frequently a difficult problem. Cheap, unreliable brooders and thermostats may easily ruin many broods of good chicks. Be sure that the brooder is large enough, is made of good material, and that the thermostat is well constructed. The latter is a particularly important feature, because a poorly made thermostat may allow temperature changes that will be very harmful to the chickens. Many commercial brooders are overrated as to their chick capacity. A 52-inch hover will accommodate 300 chicks, providing approximately 7 inches of hover space for each chick.

There is considerable fire risk from brooders, another reason for selecting well-built machines.

For the farmer who raises from 400 to 600 chicks annually two brooder stoves would be satisfactory, one for the first hatch and another for the second. They are not expensive to operate and save much time

in caring for the chicks. They are particularly serviceable to farmers who raise about 200 or more chicks annually.

Operation of the brooder

Chicks are usually left in the incubator from 24 to 36 hours after hatching, without feeding, before they are removed to the brooder, which should have been in operation 3 or 4 days at the proper temperature for receiving chicks. A beginner should try his brooding system carefully before he uses it. Early mortality in chicks sometimes results from the chilling they receive while being taken from the incubator to the brooder and also as a result of not having the brooder running properly when the chicks are first put under the hover. In cool or cold weather the chicks should be moved in a baby-chick box or other covered receptacle, and the temperature under the hover should be about 95° F.

The floor of the brooder house, under and around the brooder, should be covered with a fine layer of cut clover, fine sand, or other litter. Sand or a 4-inch slab of concrete may be used around oil and coal stoves to make the floor fireproof. Care must be taken, of course, to keep combustible litter away from these stoves especially when removing ashes. Chicks should be fed just as soon as they are put in the brooder to keep them from getting hungry and eating the sand or litter. Sheets of newspapers may be used under and around electric brooders for the first few days if they are changed daily. Peat moss, shavings, ground corn cobs, cut straw, or sand may be used on the floor of the brooder house and make suitable litter for the chickens after they are a few days old. Peat-moss litter is not usually renewed until the end of each brooding period. The surface of sand litter is raked off about once a week.

At first when chicks are put under the brooder they should be confined around the hover by placing a guard of one-half inch mesh wire around the hover. The position of the wire depends on the shape of the hover and on the kind of brooder. The wire should be moved farther and farther from the hover and discarded entirely when the chicks are about 1 week old or when they are thoroughly trained in the use of the brooder (fig. 7). Pieces of wire mesh put across the corners of the house will prevent the chicks from crowding into the corners. This is important because many chicks may be smothered as a result of piling up in the corners Baby chicks should be watched closely to see that they do not huddle or get chilled. If they begin the bad habit of toe picking, remove the wounded ones and paint their toes with tar. Getting the chicks outdoors will serve to check this habit.

The best temperature at which to keep a brooder depends on the position of the thermometer, the style of the hover, the age of the chicks, and the weather conditions. The chicks should always be kept comfortable. When too cold, they will crowd together and try to get nearer the heat. If in the morning the droppings are well scattered under the hover, it is an indication that the chicks have had heat enough. If the chicks are comfortable at night, they will spread to the edge of the hover, the position of the chicks varying somewhat with the different types of brooders and hovers. Too much heat causes them to pant and gasp and sit with their mouths open.

It is impracticable to state the temperature at which brooders of each style should be kept. In most cases the brooder should be started at about 95° F., and the stove brooders are usually kept at that temperature for the first few weeks, because the chicks are able to adjust themselves to the heat, moving nearer or farther from the heat, according to the outside temperature. Small electric brooders and brooders with small hovers are usually started at about 95° and the temperature is reduced from 3½° to 5° weekly down to 70°. The best temperature to use depends on the season of the year, the number of the chickens, and the style of the brooder. As the chickens grow larger and need less heat, it may be supplied at night only, and later on cold nights as needed. Care should be taken to prevent chilling or overheating the chickens, which weakens them and may result in bowel trouble. The heat is usually cut off after the chickens are well feathered. Early in the season heat may be necessary for 8 to 12 weeks; later it may not be needed for more than 4 to 6 weeks.

Chicks need a cool place for exercising. The brooder stove is usually placed in the back part of colony brooder houses so that the front of the house will be cooler, or the brooder house may be divided into two sections, one in which the stove is placed, and one a cool room for exercising and feeding. When the chickens are a few weeks old, low roosts should be placed in the rear of the brooder house. The chickens will soon learn to roost, and this will prevent overcrowding on the floor (fig. 9). Poultry raisers should bear in mind that chicks grow rapidly and frequently do not get ventilation enough if allowed to pile up on the floor.

The chicks should be allowed to run on the ground whenever the weather is favorable, provided the soil is not contaminated with worm eggs or disease germs. Be sure that the chicks can get in and out of the doorway readily; put a wire runway at the doorway. In many poultry plants where trouble has been experienced with coccidiosis and intestinal worms, the chicks are confined to the brooder house or allowed only on small wire-floored sun porches or cinder or concrete yards for the first 4 to 10 weeks. Keeping the chicks off the ground during this period tends to control coccidiosis and worm infestation. Further information on controlling internal parasites is contained in Farmers' Bulletin 1652, Diseases and Parasites of Poultry. When the chicks are first allowed to go outside they should be confined by a low wire fence which is taken away after about 2 weeks.

BROODER HOUSES

The houses in which chicks are brooded and reared should be well constructed and should be built so as to promote the comfort and best growth of the chicks. A brooder house should be large enough so that the chicks are never crowded. It should be dry, easy to clean, well-ventilated, and free from drafts. Harmful gases may collect around the brooder in a poorly ventilated brooder house.

The number of chickens to put in a brooder house or pen is affected by the length of time that the chickens are to be raised in these houses and by the amount of outside yard or range space. About half a square foot of floor space should be provided per chick for the first 8 weeks. Where the chickens are raised on range from 200 to 350 chickens are put in colony brooder houses 10 by 12 or 10 by 14 feet

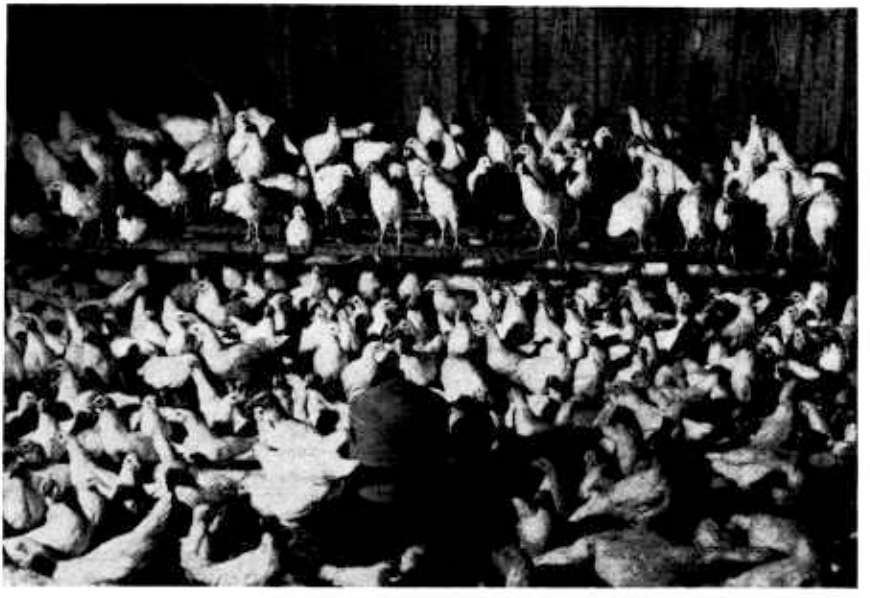

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FIGURE 9.—Interior of brooder house equipped with low roosts, which encourage chickens to begin roosting early.

in size. It is not usually considered desirable to try to brood more than 400 chickens in 1 flock in the colony houses. A colony brooder house 12 by 16 feet will hold 400 chickens, but such a large house is difficult to move.

The cockerels are usually removed when they are 6 to 8 weeks old and the pullets are raised in these colony brooder houses until they are ready to go into their laying quarters. Smaller lots of chickens are brooded in smaller pens in the long brooder houses, equipped with outside sun porches, and the pullets are usually put in cheap range shelters when they are from 6 to 10 weeks old, the time depending on the season of the year and on climatic conditions.

Brooder houses may be of stationary or portable types, as shown in figures 10 and 11. Portable, or colony, houses are built on heavy runners so they can be moved. Houses should not be located within 50 feet of other frame buildings. The colony brooder house (fig. 10) has openings on all sides for summer ventilation. The brooder-stove chimneys usually are placed at one end of the house. A ventilated thimble should be installed where the pipe passes through the wall. Houses built with the pipe projecting through the roof require a special attachment around the pipe to keep water from running down the pipe and affecting the brooder stove and to protect the roof from fire. Colony brooder houses should be of sufficient size and height to provide convenient headroom for the attendant who tends the brooder or feeds the chicks.

A long stationary brooder house with a wire-floored sun porch on the south side of the building is shown in figure 11. The brooder houses illustrated in figures 10 and 11 are used with satisfactory results at

the Government research farm, Agricultural Research Center, Beltsville, Md.

Plans for houses suited to conditions in any State may be obtained by writing to the poultry department of the State college of agriculture.

Chickens should be raised on new ground each year. This can be done readily by setting aside two fields in which to rear the chicks and using one field for chicks 1 year while the other field is in grass or growing a crop. Be sure, however, that the land used by the chicks has good grass or is in clover, alfalfa, or some other tender green feed (fig. 10). Where there is a large orchard it may be divided into two parts, each part being used every other year.

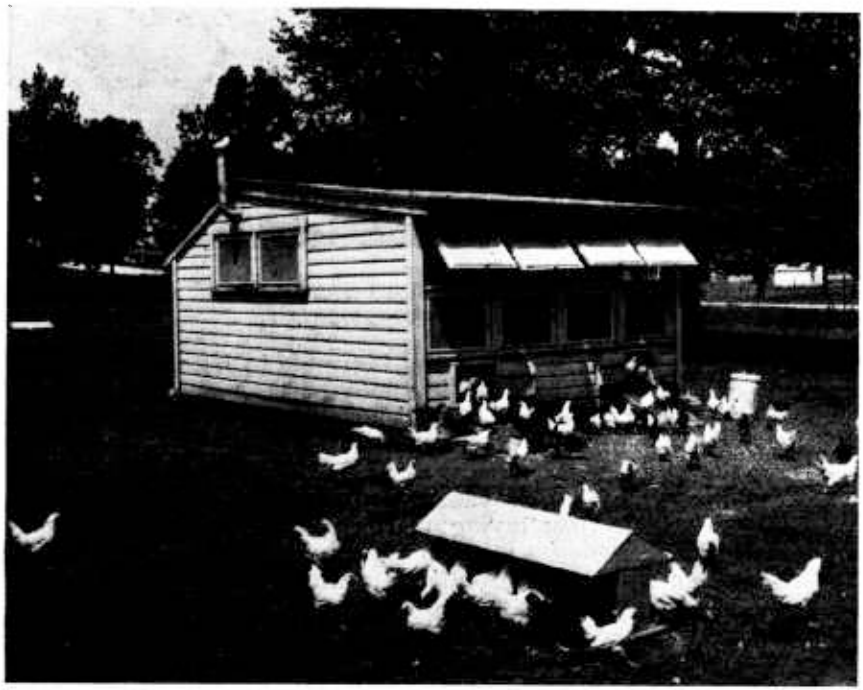

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FIGURE 10.—Hip-roof brooder house, 10 by 14 feet, on grass range with ample shade available. Note glass substitute windows which may be opened to provide ventilation.

There should be shade where the chicks are being reared, and if shade trees are wanting, a growing crop, such as corn, provides shade. At the same time the houses should be put where the chicks have ready access to plenty of green feed.

Many farmers and poultrymen would find it distinctly to their advantage to set aside two fields of the farm for the exclusive purpose of rearing chicks alternately with raising a crop. By following such a system about 750 chicks could be raised on 2 acres of good soil, divided into 2 fields with 1 acre in each.

Above all, chicks should not be raised on the same land year after year, because soil contamination is one of the most important causes

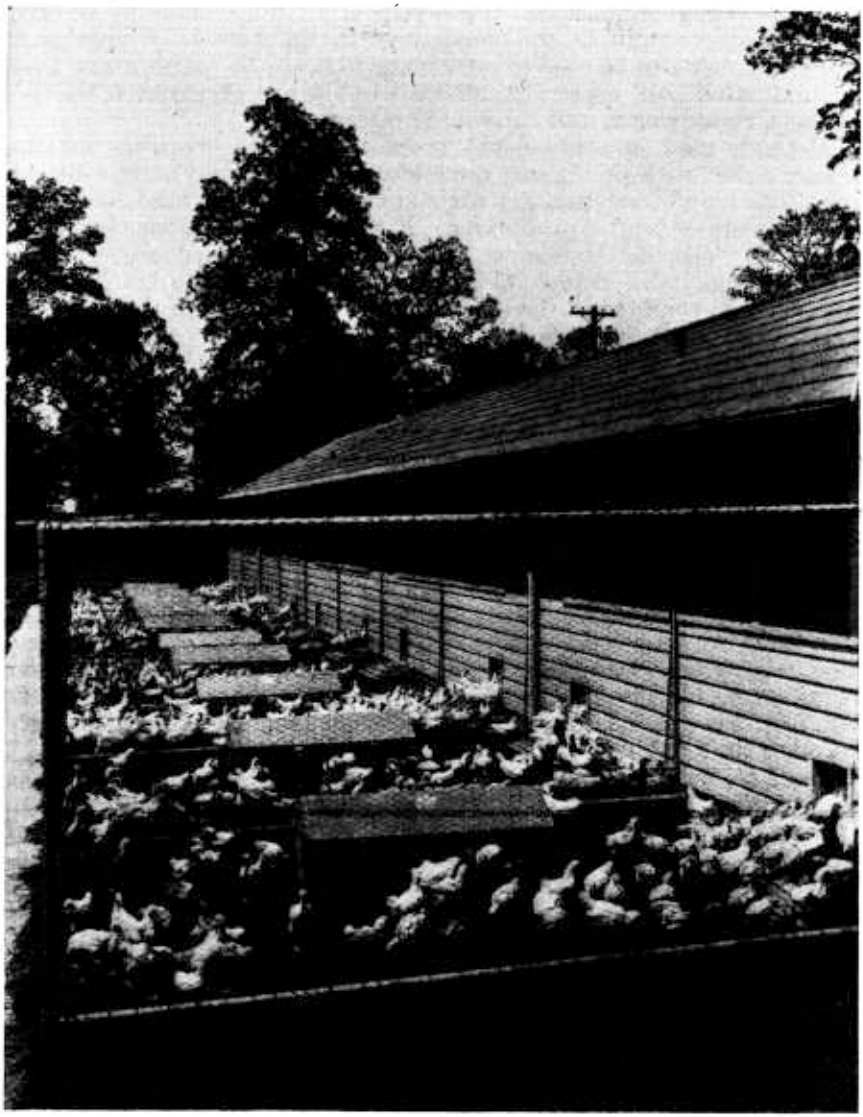

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FIGURE 11.—Long brooder house equipped with wire-floored sun porches and electric brooders.

of failure in raising chicks. On alternate years the ground should either be kept in grass or cultivated and sowed to a crop.

BROODING CHICKS IN CONFINEMENT

In many sections of the country, especially where commercial poultry raising is carried on extensively, chicks are brooded in confinement. This method can be used successfully if suitable diets and good brooding methods are used. Leg weakness, which is likely to occur in

chickens kept confined indoors, can be prevented by including suitable amounts of vitamin D and manganese in the ration. Confinement brooding may also be used to advantage to keep the chicks away from contaminated soil, especially where trouble has occurred from coccidiosis, roundworm, and tapeworm infestation.

Methods used in confinement brooding include brooding in long houses either with or without outside sun porches, and battery brooding. The long brooder houses without sun porches are used commonly for commercial broiler production. Either the long brooder houses or the colony brooder houses with sun porches attached are used for brooding chicks in semiconfinement (figure 11). The chickens are usually kept confined in these houses and yards through the brooding period and until they are 8 to 12 weeks old. Pullets that are to be raised for egg production or for breeding are then transferred to inexpensive range shelters.

BATTERY BROODING

Battery brooding is well adapted for starting chicks and for broiler production. Chicks may be started in battery brooders and kept there from 1 to 3 weeks before they are transferred to other brooders. Batteries are sometimes used to carry these chickens through the brooding period and are used quite extensively for raising broilers up to 2 to 3 pounds in weight. Electrically heated batteries are usually operated in a room where a temperature of from 60° to 70° F. is maintained. The battery brooder is usually started at about 95° and the brooder temperature is reduced to 75° by the time the chickens are 4 to 5 weeks old. At this age the chickens may be taken from the nursery battery brooders and put in growing batteries.

Some commercial broiler raisers who maintain very uniform room temperatures start the brooders at somewhat lower temperatures than this and reduce the heat more rapidly. A fairly rapid reduction of temperature in the battery and a cool room temperature tend to stimulate good feather growth in broilers.

As the chickens are closely confined, the feeding and management conditions must be kept just right for successful brooding in batteries. From 9 to 10 square inches of the battery floor space should be allowed for each baby chick. To prevent crowding, this space per chick should be increased to about 18 square inches at 3 weeks, 30 inches at 6 weeks, and 50 inches at 10 weeks. Difficulties, such as picking, overcrowding, and leg weakness, are more likely to occur with chickens in battery brooding than with those having access to outside yards.

One great advantage in brooding chicks in confinement, particularly where large numbers are raised during the winter months, is the saving of labor. Either the individual-brooder or a continuous-brooder system is used in a long brooder house, which is divided into a number of pens, each large enough to accommodate from 200 to 500 chickens. Such an arrangement requires much less labor in tending the chicks than does brooding under the colony brooding system, with the colony houses 100 to 125 feet apart.

NECESSARY PRECAUTIONS

Brooding chicks in confinement is an adequate precaution against intestinal roundworm infestation and also prevents losses from coc-

cidiosis provided the organisms of that disease are not taken into the house in litter or on the feet of the attendant. Should that happen and coccidiosis gain an entrance into a long brooder house containing several thousand chicks, the losses may be heavy. Brooding chicks in confinement is not necessarily a safeguard against tapeworm infestation, but the amount of infestation is reduced materially. When chicks are brooded in confinement it is important that the brooder house be kept in a strictly sanitary condition at all times.

Although brooding chicks in confinement saves labor, it also requires more careful management to avoid losses than does rearing chicks on range under the colony system, especially if new land is used each year. Not only do chicks brooded in confinement need more careful attention than chicks brooded on range, but there is also greater danger of overcrowding the houses, especially if the chickens are kept after they are 8 to 10 weeks old.

The space needed per chick depends on how long the birds are to be kept in the house. Up to 8 weeks, ½ square foot of floor space per chicken should be provided; from 8 to 12 weeks, about 1 foot, and from 12 to 20 weeks 1½ feet. In some of the long brooder houses where broilers are raised under coal brooder stoves, 400 chickens are brooded in pens 10 by 20 feet and 400 to 500 birds are raised in a double pen, 20 by 20 feet, until they are marketed at 3 pounds weight.

Feather picking and cannibalism are frequently encountered when chicks are brooded in confinement. Toe picking is usually the first trouble to make its appearance and may develop when the chicks are but a few days old. Tail picking may develop shortly after feathers have replaced the down, and body picking sometimes occurs as an aftermath of tail picking. Any one of the three troubles may occur when good rations are being fed and when all conditions of brooder management are considered satisfactory.

These vices can usually be stopped by increasing the salt content of the diet for 2 or 3 days. If an all-mash diet is used, 2 percent of salt is added; but if both mash and grain are fed 4 percent of salt is added to the mash. If the salt treatment does not stop the feather picking or cannibalism within 3 days, it may be advisable to trim back to the quick the upper mandible of the beak. Providing ruby-colored light in the pen, either by the use of colored bulbs or by painting the windows will help to prevent toe picking and feather picking. The simplest way to stop these vices is to let the chickens out of the brooder houses, where this is practical.

For the production of broilers, brooding in confinement has been proved to be satisfactory, but where pullets are being raised for laying purposes it is advisable to give them range on clean soil.

PROBABLE CAUSES OF POOR RESULTS IN BROODING

Overcrowding is a very common cause of failure in brooding. Methods of brooding may have been at fault. The temperature may have been uneven, causing the chicks to become chilled, giving rise to such conditions as brooder pneumonia or bowel trouble. Poor-quality chicks are frequently a cause of poor results in brooding. The chicks may have come from weak or diseased breeding stock. Adverse conditions of incubation may have affected the quality of the chicks. Lack of proper sanitation in the brooder houses and contaminated soil are

factors that frequently cause high mortality in chicks. Safeguarding against all these conditions will help to insure success.

CARE OF CHICKENS AFTER THE BROODING SEASON

In order that the growth of the chickens may proceed normally after the brooding season, certain practices should be followed. A brooder house large enough to accommodate about 350 chicks during the brooding season is too small for that number when they are about 10 or 12 weeks old. At this age the chickens should be well feathered and should have learned to roost. Unless they are given more house-room they are liable to get overheated on warm nights. Putting low roosts in the brooder house, when the chickens are a few weeks old, helps to prevent crowding (fig. *9*).

One good way of providing more room is to separate the sexes. This avoids the possibility of the cockerels annoying the pullets, and is especially desirable in order to allow the pullets to mature properly. Moreover, the cockerels may be sold as broilers or fryers early in the season or may be reared by themselves and sold as roasters in the fall of the year.

During the summer months the houses should be well ventilated. This can be done by opening the windows and ventilators on all sides of the house. Range shelters provide excellent summer ventilation, as all sides of the building are open.

The chickens should be culled from time to time throughout the growing season. Weak chickens should be removed as they appear, because they rarely develop into profitable birds. Diseased chickens should be removed at once and burned or buried; otherwise the healthy chicks may become contaminated. The houses and the land should be kept in sanitary condition at all times, since it is the best insurance against ill health and promotes the best growth. Shade is very desirable for growing chickens, and this can be provided artificially if no natural shade is available. The growth of the chickens depends on the feeding and care provided.

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